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动物分类学报

内蒙古道虎沟中侏罗世小蝎蛉科 (昆虫纲, 长翅目) 昆虫化石

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摘 要 描述小蝎蛉科化石 1 新属 2 新种: 多脉原始小蝎蛉 *Protochoristella polyneura* gen. et sp. nov., 美丽原始小蝎蛉 *P. formosa* gen. et sp. nov.。简要讨论了小蝎蛉科的起源与演化。所有化石标本均采于内蒙古宁城道虎沟中侏罗世九龙山组地层, 模式标本现保存于首都师范大学生命科学学院。

关键词 长翅目, 小蝎蛉科, 新属, 新种.
中图分类号 Q915. 819. 7

小蝎蛉科 Nannochoristidae Tillyard, 1917 是现生长翅目中的一个小科, 目前已知现生种类 2 属 8 种 (Penny, 1975), 其中 *Nannochorista* 分布在澳大利亚东部和南美, *Microchorista* 仅在新西兰发现; 化石种类 6 属 10 余种, 产于澳大利亚晚二叠世的 *Neochoristella* 和 *Nannochoristella* (Riek, 1953); 产于东亚外贝加尔侏罗系下部地层的 *Dahurochorista*, *Dahurolarva* 和 *Itaphlebia* (Sukatcheva, 1985), 以及产于中国北京早白垩世卢尚坟组的 *Jichoristella* (Ren, 1995), *Sukatcheva* (1985) 最初将 *Itaphlebia* 属归入中生蝎蛉科 Mesopanorpodidae, 随后 Novkoshonov (1997) 将其转移到小蝎蛉科中。小蝎蛉类不仅是进化上的孑遗类群, 而且无论成虫还是幼虫的形态特征都代表了长翅目和双翅目之间的中间类型 (Grimaldi & Engel, 2004), 因而是长翅目昆虫演化的一个重要环节。

自内蒙古宁城道虎沟的九龙山组 (Jiulongshan Formation) 地层中采到大量的昆虫化石 (Liu *et al*., 2006; Yao *et al*., 2006; Zhang *et al*., 2006), 其中包括本文的 2 种小蝎蛉科化石。化石的地质时代应归为中侏罗世 (Ren *et al*., 2002; Tan *et al*., 2006)。

本文化石的鉴定和初步描绘主要借助于 Leica MZ12. 5 显微镜附带绘图仪辅助完成, 所有的线条图借助于 CorelDraw 12 绘图软件完成。

长翅目 **Mecoptera Packard, 1886**

小蝎蛉科 **Nannochoristidae Tillyard, 1917**

Nannochoristidae Riek, E. F 1953 *Rec. Aust. Mus*., 23: 55-87.

Nannochoristidae Sukatsheva, I. D. 1985 Trudy Paleontol. Inst. Akad. Nauk SSSR 211. Nauka, Moscow. 96-114 (in Russian).

Nannochoristidae 任东, 1995. 北京与邻区侏罗- 白垩纪动物群及其地层. 91~ 94.

Nannochoristidae Novkshonov, V. G. 1997. *Vestnik Permskogo Univ*., 4: 124-136 (in Russian).

科征 成虫虫体小, 喙短细。前翅一般长 5. 5~ 8. 5 mm, 翅痣明显, Sc 脉长, 伸达翅痣区; Rs 脉通常 3 分支; M 脉 4 分支; CuA 脉末端与 M 脉愈合很长一段距离。后翅与前翅相似, 但 Sc 脉较短, 且 CuA 与 M 脉愈合的部分较短。

分布: 澳大利亚, 南美洲, 西伯利亚, 哈萨克斯坦, 蒙古, 中国; 晚二叠纪—现在。

原始小蝎蛉属, 新属 Protochoristella **gen. nov.**

模式种: *Protochoristella polyneura* sp. nov.

鉴别特征 虫体小, 喙短细。前翅翅痣清晰, Sc 脉长, 分 2 支, 延伸到翅痣区域; R_1 不分支, Rs 脉 4 分支, 分叉早于 M 脉分叉; M 脉 4 分支, 在翅中部开始分叉; CuA 脉和 M 脉在基部愈合较长的一段距离, 在两脉分离处形成 Y 形脉; CuA 和 CuP 之间有 2 支横脉。后翅 Sc 脉短, 且 CuA 脉和 M 脉在基部愈合的部分较短。

比较 新属 Rs 4 分支与 *Neochoristella* Reik, 1953, *Nannochoristella* Riek, 1953, *Dahurochorista* Sukatsheva, 1985, *Dahurolarva* Sukatsheva, 1985, *Jichoristella* Ren, 1995 以及两个现生属均明显不同; 新属的翅脉与 *Itaphlebia* (Sukatcheva, 1985) 相似, 但新属 R_1 不分支, Rs 和 M 脉分叉均比较早, 1A 和 CuP 之间无横脉与 *Itaphlebia* 差异明显。

词源: Protochoristella 源于希腊词 Proto- (原始的) + choristella (小蝎蛉科 Nannochoristidae 中一现生属 *Choristella*), 阴性。

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多脉原始小蝎蛉，新种 Protochoristella polyneura **sp. nov.** （图 1~ 5，10）

正模：一块保存完整的雌虫标本，编号：CNU-M-NN-2006049。

产地及层位：内蒙古宁城，中侏罗统九龙山组。

描述　虫体小，长6.5 mm（不包括触角和尾须），在身体每一侧有两对翅，翅对称，前翅和后翅的翅脉都非常清晰。

喙短细，下颚须 4 节；触角丝状，保存不完整，可见 30 余节。前、后胸背板较小，中胸背板发达。足细长，其上密布不规则排列的刚毛，跗节较其它各节长，5 节，基跗节长于其它各节之和，前跗节末端具两个爪。腹节可见 10 节，第 1 腹节与后胸愈合，较小，腹部末端有 1 对尾须，分 2 节。

前翅狭长，长7.5 mm，宽2 mm，基部轻微缢缩，顶角边缘稍圆，翅痣清晰可见，Sc 脉 2 支，伸达翅痣区域；R_1 简单，不分支，伸达翅缘，在接近末端处向翅痣处弯曲；Rs 脉从基部发出，4 支，在接近翅中点开始分叉，R_{4+5} 分离早于 R_{2+3}；M 脉 4 分支，M_{3+4} 比 M_{1+2} 分离早，但晚于 R_{4+5}；CuA 脉和 M 脉在基部愈合较长一段距离，且 CuA+ M 在出发处与 R 脉愈合较短的一段距离；CuP 脉简单，在 CuA 脉和 CuP 脉之间有 2 支横脉；1A 和 2A 简单，但两脉之间有 2 支横脉存在。后翅较小，但比前翅略宽；Sc 脉短，且 CuA 脉和 M 脉在基部愈合的部分较短，CuA 脉和 M_{3+4} 间无横脉，CuP 脉与 CuA 脉之间的横脉也缺失，2A 未保存；其它翅脉特征与前翅相似。

词源：“polyneura”源自拉丁词“polyneurus”，多脉的。

美丽原始小蝎蛉，新种 Protochoristella formosa **sp. nov.** （图 6~ 9，11）

正模：保存完整的雌虫标本，编号：CNU-M-NN-2006006。

产地及层位：内蒙古宁城，中侏罗统九龙山组。

描述　虫体小，体长7 mm（不包括触角和尾须）翅对称，前后翅有一定程度的交叠，因此前翅翅脉清晰可见，后翅翅脉不可辨别。

头部顶端没有明显凸起，喙不完整，下颚须 4 节，复眼明显；触角丝状，保存不完整，可见 30 余节。前、后胸背板较小，中胸背板发达。足细长，其上密集刚毛，排列不规则，胫节长，可见 1 胫端距，跗节 5 节，基跗节最长，前跗节末端具两个爪。腹部可见 10 节，第 1 腹节与后胸愈合，较短，腹末 2 节突然变细，最末腹节伸出 2 个尾须，每个分 2 节。

前翅长8 mm，宽3 mm，基部轻微缢缩，顶角略圆；翅痣清楚，Sc 长，2 分支，延伸到翅痣区域；R_1 伸达翅缘，接近末端处向翅痣强烈弯曲；Rs 从基部发出，4 分支，在翅中点前开始分叉，R_{4+5} 分叉较早，R_{2+3} 简单；M 脉在接近翅基处发起，4 分支，M_{3+4} 分叉早于 M_{1+2}，但晚于 R_{4+5}；CuA 脉在基部与 M 脉愈合很长一段距离，且在横脉 cua-m 之后轻微弯曲；CuP 脉清晰，远离 CuA 脉，但通过 2 条横脉相连；1A 和 2A 简单。后翅较前翅略小，但较宽，翅脉不可辨别。

比较：新种 R 脉在基部没有与 M+ CuA 脉愈合一段距离，且两 A 脉之间没有横脉与 *Protochoristella polyneura* sp. nov. 不同。

词源：“formosa”源自拉丁词“formosus”，美丽的。

讨论　小蝎蛉类是长翅目中最古老的昆虫之一，在劳亚大陆最早记录为早侏罗世，在澳大利亚最早记录为晚二叠世（Ren，1995）。已经发现的化石种类显示小蝎蛉科在整个中生代分布都非常广泛，主要分布于澳大利亚、哈萨克斯坦、西伯利亚、蒙古和中国等地。我国中生代地层中发现了许多长翅目昆虫化石，但目前有关小蝎蛉科的报道仅有 1 属 1 种：*Jichoristella rara* Ren，1995（Ren，1995）。

关于小蝎蛉科的系统演化，Novokshonov（1998）认为该科是从二叠纪的 Permochoristidae 中足上刚毛不规则排列的一类直接演化而来。从该科的特征来看，前翅 M 脉和 CuA 脉基部愈合较长一段距离，横脉 cua-cup 转移到 M+ CuA 的分歧处；此外，后翅 Sc 脉短，并且其末梢弯曲形成了类似横脉 c-r，所有这些特征都显示了其不同于其他科的自由衍征（Novkshonov，1998，2004；Willmann，1987）。N. D. Penny（1975）研究了小蝎蛉科的地质历史，认为小蝎蛉类最初可能起源于 Permochoristidae 中翅脉 Rs4 分支的 *Petrochorista* Martynova，1933，然后由 *Petrochorista* 经过翅脉简化逐渐演变成现代小蝎蛉类群的祖先。从特征上来看，虽然 *Petrochorista* 的翅顶端较宽，R_1 有分支以及 M 脉分支较多，与新属差别较大，但新属 Sc 脉有分支，Rs 脉分 4 支，存在横脉 cua-cup 等特征都与 *Petrochorista* 相似，因而新属可能经由 *Petrochorista* 演化而来。目前关于小蝎蛉科的最早记录是发现于澳大利亚晚二叠纪的 *Neochoristella* Riek，1953 和 *Nannochoristella* Riek，1953，但两个属的翅脉非常简化，Rs 脉分 3 支，横脉少，后者更加简单，M 脉也简化为 3 支，Novkshonov（1997，1998）

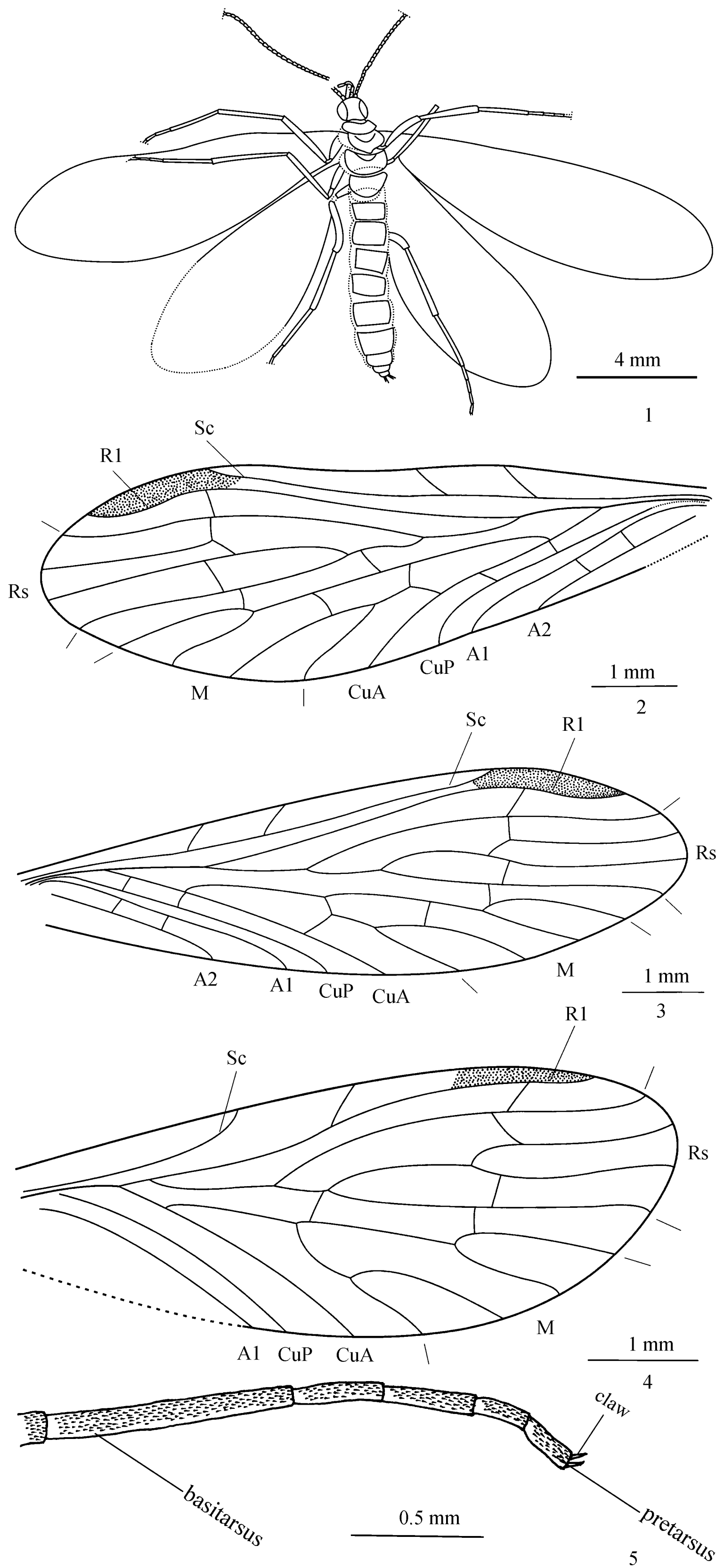


图 1~ 5　多脉原始小蝎蛉，新种 *Protochoristella polyneura* sp. nov. 正模，♀ (holotype) CNU-M-NN-2006049
1. 虫体 (body)　2. 左前翅翅脉 (left forewing)　3. 右前翅翅脉 (right forewing)　4. 右后翅翅脉 (right hindwing)　5. 后足跗节 (hind tarsus)

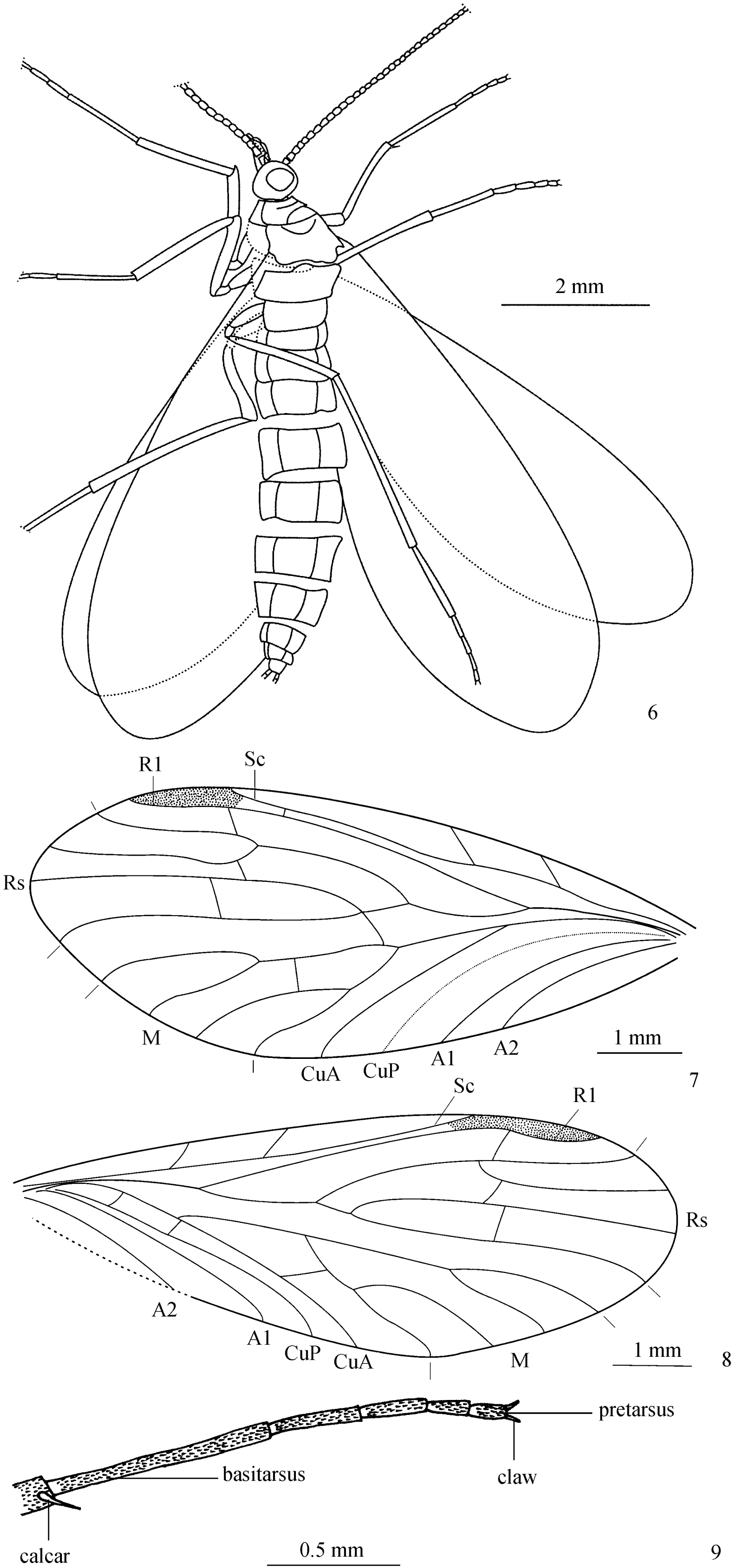


图 6~ 9 美丽原始小蝎蛉，新种 *Protochoristella formosa* sp. nov. 正模，♀ (holotype) CNU-M-NN-2006006
6. 虫体 (body) 7. 左前翅翅脉 (left forewing) 8. 右前翅翅脉 (right forewing) 9. 前足跗节 (fore tarsus)

认为这两个属并不是小蝎蛉的典型代表，且他认为翅脉简化是长翅目昆虫的进化趋势之一。与以上两属相比，新属却有着更多的比较原始的特征，如 Rs 分4 支，横脉较多。所有这些显示新属为小蝎蛉科中较原始的类群之一，甚至是 Penny (1975) 所推断的小蝎蛉科的原始祖先，是从 *Petrochorista* 演化到现代小蝎蛉科的较早的中间类群。

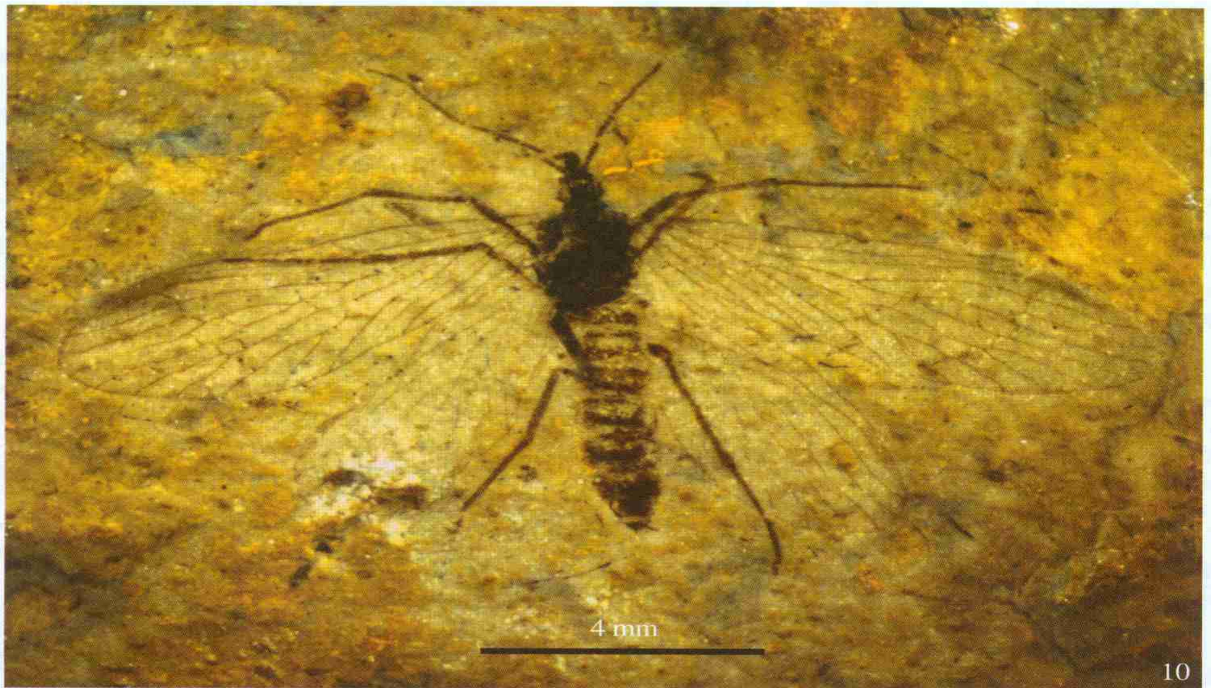


图 10　多脉原始小蝎蛉，新种 *Protochoristella polyneura* sp. nov. 正模，♀（holotype）CNU-M-NN-2006049

图 11　美丽原始小蝎蛉，新种 *Protochoristella formosa* sp. nov. 正模，♀（holotype）CNU-M-NN-2006006

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MIDDLE JURASSIC NANNOCHORISTIDAE FOSSILS FROM DAOHUGOU, INNER MONGOLIA IN CHINA (INSECTA, MECOPTERA)

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Abstract In this article, one new genus and two new species were described. All of them were collected from the Middle Jurassic Jiulongshan Formation of Inner Mongolia in China and deposited in the Capital Normal University. The origin and evolution of Nannochoristidae are discussed briefly.

Protochoristella **gen. nov.**

Type species. *Protochoristella polyneura* sp. nov.

Diagnosis. Small insect, rostrum short and slender. The forewing pterostigma clearly present. Sc long, 2-branched, reaching the pterostigmal region. R_1 not branched, Rs 4-branched, forking earlier than M. M 4-branched, CuA and M fused for a long distance, cubito-median Y-vein existent. 2 cross-veins between CuA and CuP present. The hindwing Sc a little shorter. CuA coalesced with M basally for a short distance.

Comparison. At present, two extant and six extinct genera have been reported (Novkoshonov, 1997). In the general venation scheme the *Protochoristella* gen. nov. somewhat resembles *Itaphlebia* (Sukatcheva, 1985), but the new genus differs from the latter by R_1 not branched, both Rs and M forking early, the cross-vein between 1A and CuP absent. The new genus also may be distinguished from other seven known genera by Rs 4-banched.

Etymology. The genus name is a combination of proto- (Greek, meaning original) and choristella (one recent genus of this family).

Protochoristella polyneura **sp. nov.**

Etymology. Polyneura from Latin, means complex veins in the wing.

Holotype. A well preserved female insect. Registration No: CNU-M-NN-2006049.

Locality and horizon. Daohugou Village, Ningcheng County, Inner Mongolia, China; Jiulongshan Formation, Middle Jurassic.

Description. Small insect, 6.5 mm long. Wings almost symmetrically arranged, with a pair on each side. Both the fore and hind wings are clear.

The rostrum short and slender, maxillary palp 4-segmented. Antennae filiform, incomplete, visible more than 30 segments.

Pro- and metathorax small, mesothorax well

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developed. Legs slender, covered with dense and tiny setae, irregular arrangement. Tarsi longer than others, 5-segmented, basitarsus longer than the sum of others, the pretarsus with 2 terminal claws. Abdomen with 10 visible segments, basitergum fused to metathorax, shorted. At the apex of the abdomen is a pair of 2-segmented cerci.

Forewing slender, 7.5 mm long, 2 mm wide, the base much narrower, apical margin rounded. Pterostigma clearly present. Sc long, 2-branched, reaching the pterostigmal region. R_1 simple, not branched, reaching the wing margin, curving posteriorly near its termination. Rs arising from the base, 4-branched, dividing into its two main branches nearly midwing, R_{4+5} forking early, R_{2+3} simple. M 4-branched, M_{3+4} forking before M_{1+2}, which forks after the forking of R_{4+5}. CuA coalesced with M for a long distance basally, M + CuA fused to R for a short distance before the forking. CuP simple, 2 cross-veins between CuA and CuP exist. 1A and 2A simple, but 2 cross-veins between them present. The hindwing smaller than forewing, but slightly broader and Sc a little shorter. CuA coalesced with M basally for a short distance. The cross-veins between CuA and M_{3+4}, CuP and CuA absent. 2A not preserved. Other veins are similar to the forewing.

Protochoristella formosa **sp. nov.**

Etymology. Formosa from Latin, means beautiful.

Holotype. A well preserved female insect, part and counterpart. Registration No: CNU-M-NN-2006006.

Locality and horizon. Daohugou Village, Ningcheng County, Inner Mongolia, China, Jiulongshan Formation. Middle Jurassic.

Description. Small insect, 7 mm long. Wings almost symmetrically arranged, with a pair on each side slightly overlapped, the veins of fore wings are clear, but hindwings not discernible.

Vertex of the head not raised, the rostrum incomplete, maxillary palp 4-segmented, eyes distinct. Antennae filiform, incomplete, visible about 30 segments.

Pro- and metathorax small, mesothorax well developed. Legs slender, covered with dense and tiny setae, irregular arrangement. Tibiae long, visible 1 terminal calcar. Tarsi 5-segmented, basitarsus longest, the pretarsus with 2 terminal claws. Abdomen with 10 visible segments, basitergum fused to metathorax, shorted, 9 and 10 segments abruptly more slender than 2-8, at the apex of the abdomen is a pair of 2-segmented cerci.

Fore wing 8 mm long, 3 mm wide, basal space shrinked slightly, apical margin rounded. Pterostigma clearly present. Sc long, 2-branched, reaching pterostigmal region. R_1 reaching the wing margin, curving posteriorly near its termination. Rs arising from the base, 4-branched, forking before midwing, R_{4+5} forking early, R_{2+3} simple. M arising close to the base, 4-branched, M_{3+4} forking before M_{1+2}, which forks after the forking of R_{4+5}. CuA coalesced with M for a long distance basally, with a slight bend after the cross-vein to M_{3+4}. CuP clearly, separated from CuA, but joined to it by 2 short cross-veins. 1A and 2A simple, cross-veins between them absent. The hindwing smaller than forewing, but slightly broader, veins not discernible.

Comparison. The new species different from *Protochoristella polyneura* sp. nov. in the following features on the forewing: M+ CuA not fused to R basally for a short distance, the cross-veins between 1A and 2A absent.

Key words Mecoptera, Nannochoristidae, new genus, new species.